ELEC3104: Digital Signal Processing  
(Block Mode Teaching)

COURSE INTRODUCTION – Summer 2010-2011

Course Staff
Course convener: Prof. E. Ambikairajah, room G6, ambi@ee.unsw.edu.au
Tutors: Dr. Tharmarajah Thiruvaran, thiruvaran@gmail.com
Laboratory Coordinator: Dr. Tharmarajah Thiruvaran, thiruvaran@gmail.com
Blackboard Assistant: Dr. Ming Sheng, m.sheng@unsw.edu.au

Course details

Credits
The course is a 6 UoC course; expected workload is 15–18 hours per week throughout the 8 week session.

Contact hours
The course consists of pre-recorded lecture videos provided for online download. Contact hours are restricted to Week 1, 3, 4, 7 and 8 of session. There are 24 hours of lab and 12 hours of tutorial in total.
The summer session officially runs over two periods in addition to the introduction in the first week, from 10/12/10 to 17/12/10, and from 24/01/10-28/01/10.
The introduction will be on the 24th of November, 2010 at 10 am at Rex Vowel Theatre. It is important that you attend the introduction in order to get the complete idea of the block mode teaching.

Tutorials: Week 4 and 8 only
Monday 13-15
Thursday 14-15,
Another 6 hours of Tutorials will be on video.

Laboratories: For group A: Week 3 Friday 9-12 and 14-17,
Week 4 Friday 9-12 and 14-17.
For group B: Week 4 Wednesday 9-12 and 14-17,
Week 4 Friday 9-12 and 14-17.
Then for both group A and B: Week 7 Friday 9-12 and 14-17,
Week 8 Friday 9-12 and 14-17.

Consultations: Your tutor will be your main source of assistance for ELEC3104. Your will be available online regularly and will be providing a consultation time upon request for which you can discuss technical and other issues in the course. You are encouraged to ask questions during and after the lab and tutorial classes.
Course Information

Context and aims
Signal Processing is the process of measuring, manipulating or analysing information. Signals of interest include biomedical data, audio, still or moving images, radar, and even DNA. Filtering techniques can be crucial in revealing and interpreting information present in a signal. ELEC3104 Digital Signal Processing is an introductory signal processing course which takes students through the steps necessary to design and implement filters for a range of signals.

Aims
The course aims to equip the student to do the following:

- Deduce and understand the behaviour of a system in terms of both its time domain and frequency domain representations.
- Identify the correct type of filter required for a given problem and be able to demonstrate the design and implementation of such a digital filter.
- Explain the concept of aliasing and its effect on the design and use of practical systems.
- Understand the concept of Multi-rate digital signal processing and its applications.

Relation to other courses
The course is a third year subject in the school of Electrical Engineering and Telecommunications at the University of New South Wales. It is a core subject for students following a BE (Electrical) or (Telecommunications) program, and an elective for Computer engineering students.

Pre-requisites
The pre-requisites for this course is ELEC2134, Circuits and Signals. It is essential that students are familiar with basic circuit theory and signal analysis.

Assumed knowledge
It is further assumed that the students are familiar with the MATLAB environment, and have good computer literacy.

Following courses
The course is a pre-requisite for all professional electives in the Signal Processing group, including ELEC4621 Advanced Digital Signal Processing, ELEC4622 Multimedia Signal Processing, and ELEC4623 Biomedical Instrumentation, Measurement and Design.

Old courses
The course replaces the previous course ELEC3004.

Learning outcomes
At the end of the course you should:
Be able to apply transform methods to the analysis of analogue and digital linear
• Be able to apply transform methods to the analysis of analogue and digital linear time-invariant systems
• Be able to convert between time and frequency domain representations of signals and systems
• Understand the practical aspects of sampling and reconstruction and be able to select a suitable sampling rate for a given signal processing problem
• Be capable of designing and analysing analog and digital filters for a given specification
• Be able to demonstrate an understanding of the use and applications of the discrete Fourier transform
• Have gained practical experience with the implementation of digital filters

The course delivery methods and course content address a number of core UNSW graduate attributes; these include:
• Analytical skills, critical thinking and creative problem solving will be developed by the laboratory experiments and interactive checkpoint assessments during the labs.
• Self-assessment of independent and reflective learning is made available through a series of tutorials spanning the duration of the course together with the video-based learning material. The laboratory program fosters independent learning.
• Demonstration of the understanding of principles, and the effective use and communication of relevant information will be tested in depth in the mid-session examination and the final examination.

Syllabus

Teaching strategies
Delivery Mode
The teaching strategies employed in this course are new, in so far as the lectures will not be face-to-face, but provided as pre-recorded videos available for online download. In addition, tutorials and laboratories are carried out in “block-mode”, where students are required to attend in Weeks 1, 3, 4, 7 and 8 only, where they will undertake all labs and tutorials in an intensive fashion. This entire course will be delivered in a new mode of teaching, using pre-recorded video lecture presentations. You will need to watch these video lectures in your own time before the tutorial classes. Advantages of the video lectures are:
• You will be able to watch them at your own pace
• You can revisit the lecture content as many times as you like
• Things that you might miss in a normal live lecture (e.g. difficult mathematical concepts) are available on the video lectures and/or via the tutorial classes.

This mode of delivery was used from 2006 for this course (actually via the use of CD’s), and it was popular with both undergraduate and postgraduate students in other courses who said that it helped them gain a deeper understanding of the course material. The video lectures use the new VCPlayer software developed here at the School of Electrical Engineering and Telecommunications.

Note that the laboratory material and the lecture material may not be entirely synchronised. The pre-recorded lectures provide you with an opportunity to cover material not yet covered in class. You should look through the laboratory notes to decide what material you need to look over.

Any student comments specifically about any issues with this mode of teaching should be directed to the course convener.

Teaching Methods

Video lectures = 36 hrs (mandatory)   Tutorials = 12 hrs (mandatory)
Labs = 24 hrs (mandatory)

The rationale behind the teaching methods for this course:
• The course is structured such that the video based lectures provide details of course material so that you can understand each concept presented and re-visit any difficult sections in detail.
• The tutorials help to develop the required level of analytical skills that will be used in this course.
• Your mid-session and final exams test your problem solving skills and give you the opportunity to effectively communicate and demonstrate your understanding of the principles in the course.
• You lab assessments test your ability to apply your theoretical knowledge and analytical skills in a practical situation.

The learning in this course is intensive for all 8 weeks of the session.

Consult the guidelines on learning that inform teaching at UNSW. These guidelines are available at www.guidelinesonlearning.unsw.edu.au

Learning in this course

You are expected to view all lectures, attend all tutorials and labs in order to maximise learning. You should prepare your tutorial questions in advance of attending the tutorial classes. You must prepare well for your laboratory classes. In addition to the lecture notes/Video, you should read relevant sections of the recommended text. Reading additional text would further enhance your learning experience. Group learning is also encouraged.

Laboratory program

The laboratory program is the centre of this course. Through the laboratory component, you will progressively encounter the elements of the syllabus. The aim of the laboratory component is to ground the analytical subject material in a real-world
problem, meaning that the skills and knowledge you learn throughout the course will be applied in real engineering design work. Throughout the session you will focus on:

- Sampling and reconstruction
- Impulse and frequency response of systems
- Description of filter types using poles and zeroes
- Digital filter design
- Frequency domain analysis
- Multi-rate processing

**Laboratory Exemption**

There is no laboratory exemption for this course. Regardless of whether equivalent labs have been completed in previous courses, all students enrolled in this course for Summer 2010-2011 must take the labs. If, for medical reasons, (note that a valid medical certificate must be provided) you are unable to attend a lab, you will need arrange a catch-up lab agreed by the laboratory co-ordinator as soon as possible.

**Pre-requisite to pass the course**

A satisfactory performance (50% or greater) in the **ongoing laboratory assessment and in the final exam** is a necessary requirement to pass this course, irrespective of your marks in the other components.

**Assessment**

The assessment scheme in this course reflects the intention to assess your learning progress through the session. Ongoing assessment through the session occurs through the lab checkpoints and the mid-session exam.

- Mid-Session exam = 15%
- Ongoing Lab Assessment = 35%
- Final Exam = 50%

**Mid-Session Exam (15%)**

There will be one mid session examination, testing your understanding of the principles and your analytical skills through a number of set problems.

- Monday, 7th of January, the time and venue will be announced later via the course website [http://subjects.ee.unsw.edu.au/elec3104](http://subjects.ee.unsw.edu.au/elec3104).
- Covers material from chapters 1, 2, 3, 4, 5, 6

If for medical reasons, (note that a valid medical certificate must be provided) you are unable to attend a class exam, you will be given an oral examination of approximately 1 hour.

**Laboratory Assessment (35%)**

Throughout the semester your progress in the laboratory will be assessed by your lab tutor at a series of checkpoints. At these checkpoints you will present your work to your tutor, explain the relevant concepts, and answer questions on your design. More information is available in the Laboratory notes.
Final Exam (50%)
The final exam will cover all the chapters and will be held during the week 07-02-2011 – 11-02-2011. The exact time and venue will be announced later.

Resources for Students

Textbooks

Prescribed textbook

Reference books

On-line resources

BlackBoard
As a part of the teaching component, BlackBoard will also be used. Mid-term examination results and lab marks will also be available via BlackBoard.

Course web page http://subjects.ee.unsw.edu.au/elec3104
BlackBoard http://telt.unsw.edu.au/
Video Lectures http://eemedia.ee.unsw.edu.au/ELEC3104_Streaming/index.htm

Mailing list
Announcements concerning course information will be given in the lectures, via the course website http://subjects.ee.unsw.edu.au/elec3104 and/or on BlackBoard.

Other matters

Academic Honesty and Plagiarism
Plagiarism is the unacknowledged use of other peoples work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a serious offence by the University and severe penalties may apply: http://www.lc.unsw.edu.au/plagiarism

Continual Course Improvement
Students are advised that the course is under constant revision in order to improve the learning outcomes of its students. Please forward any feedback (positive or negative) on the course to the course convener or via the Course and Teaching Evaluation and Improvement Process.

Administrative Matters
On issues and procedures regarding such matters as special needs, equity and diversity, occupational heath and safety, enrolment, rights, and general expectations
of students, please refer to the School policies: http://scoff.ee.unsw.edu.au/

**Important Points**

**Please note the following:**

- During your lab sessions, you will be assigned to a lab tutor, who will be able to guide you in your laboratory-based learning.

- You will be able to purchase the lecture notes (hard copy + CD based lectures) which contains course outline, MATLAB exercises, tutorial problem sheets and solutions, sample quizzes, final exam papers, references and laboratory manual along with lecture notes. This costs $25 and can be purchased from the School Office.

- A soft copy of the lecture notes is available on the course website: http://subjects.ee.unsw.edu.au/elec3104

- It is vital that you attend all tutorials and labs and view the lecture videos.

- Guidelines on learning that inform teaching at UNSW are available at www.guidelinesonlearning.unsw.edu.au
# Course Schedule

Indicative lecture schedule

<table>
<thead>
<tr>
<th>Period</th>
<th>Topic</th>
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</thead>
<tbody>
<tr>
<td>Week 1-4</td>
<td>Chapter 1: Signal and Systems</td>
</tr>
<tr>
<td>Week 1-4</td>
<td>Chapter 2: Discrete-Time Systems</td>
</tr>
<tr>
<td>Week 1-4</td>
<td>Chapter 3: An Introduction to the $z$-Transform</td>
</tr>
<tr>
<td>Week 1-4</td>
<td>Chapter 4: Fourier Representation of Signals</td>
</tr>
<tr>
<td>Week 1-4</td>
<td>Chapter 5: Digital Signal Processing</td>
</tr>
<tr>
<td>Week 1-4</td>
<td>Chapter 6: Discrete-Time Fourier Transform</td>
</tr>
<tr>
<td>Week 5</td>
<td>Mid-Session Exam (chapters 1, 2, 3, 4, 5, 6)</td>
</tr>
<tr>
<td>Week 5-8</td>
<td>Chapter 7: Analogue Filter Design</td>
</tr>
<tr>
<td>Week 5-8</td>
<td>Chapter 8: Digital Filter Design</td>
</tr>
<tr>
<td>Week 5-8</td>
<td>Chapter 9: Multirate Digital Signal Processing</td>
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<tr>
<td></td>
<td>Final Exam (all chapters) during the week 7-11 of Feb, 2011</td>
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</tbody>
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# Laboratory Schedule

<table>
<thead>
<tr>
<th>Week and day</th>
<th>Suggested Lab work</th>
<th>Time required</th>
<th>Required Chapters</th>
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</thead>
<tbody>
<tr>
<td>*</td>
<td>Lab1 - Introduction to TIMS and Matlab</td>
<td>2 hours</td>
<td>1, 2</td>
</tr>
<tr>
<td>*</td>
<td>Lab 2 - Sampling and Reconstruction</td>
<td>4 hours</td>
<td>1, 2, 3, 5</td>
</tr>
<tr>
<td>Week 4 Friday</td>
<td>Check point 1 (only in Matlab and TIMS isn’t required)</td>
<td>2 hours</td>
<td>1, 2, 3, 5</td>
</tr>
<tr>
<td>Week 4 Friday</td>
<td>Lab 3 Impulse and Frequency Response of Systems</td>
<td>2 hours</td>
<td>2, 3, 4, 5, 6</td>
</tr>
<tr>
<td>Week 4 Friday</td>
<td>Lab 4 Poles and Zeros</td>
<td>2 hours</td>
<td>3, 4, 5, 6</td>
</tr>
<tr>
<td></td>
<td>Check point 2</td>
<td>2 hours</td>
<td>1, 2, 3, 4, 5, 6</td>
</tr>
<tr>
<td>Week 7 Friday</td>
<td>Lab 5 Digital Filters</td>
<td>4 hours</td>
<td>7, 8</td>
</tr>
<tr>
<td>Week 8 Friday</td>
<td>Check point 3</td>
<td>2 hours</td>
<td>5, 8, 9</td>
</tr>
<tr>
<td>Week 8 Friday</td>
<td>Lab 6 Interpolation and Decimation</td>
<td>4 hours</td>
<td>5, 8</td>
</tr>
</tbody>
</table>

* - Week 3 Friday for Group A and Week 4 Wednesday for Group B